SPACE TRANSPORTATION SYSTEM 98 (STS-98)

Introduction and Background

The JSC Toxicology Group, as part of its program to ensure a toxicologically safe environment during Space Shuttle missions, analyzes samples of cabin air taken during each mission. These procedures help determine the effectiveness of contamination control measures that are designed to maintain a safe internal environment during missions.

Sampling and Analysis

Samples of cabin air were taken in evacuated grab-sample canisters (GSCs) immediately before launch, and at MET 10/13:24 from the middeck area. The samples were sent to the JSC Toxicology Laboratory for analysis by gas chromatography and mass spectrometry (GC/MS) according to methods described in applicable work instructions.

A toxicological evaluation of the air requires that spacecraft maximum allowable concentrations (SMACs) of every component of the mixture of contaminants be considered rather than the concentration of each individual contaminant. The potential toxicity (T) of the mixture of "n" airborne contaminants in each sample was determined by adding the ratios of each concentration (C) to the appropriate 7-day SMAC. The 7-day SMACs were used in the calculation because the length of the mission was closer to 7 days than 30 days. The equation is shown below:

$$T = C_1/SMAC_1 + C_2/SMAC_2 + ...C_n/SMAC_n$$

Values of "T" below 1.0 for each toxicological category (e.g. irritants, cardiotoxicants, etc) indicate that the mixture of contaminants measured in the air was toxicologically safe to breathe at the time and place of sampling.

Data were made available to the Toxicology Group by the Crew and Thermal Systems Division on their measurements of carbon dioxide in the middeck. Their method employs an electrochemical sensor to quantify carbon dioxide on a nearly continuous basis.

Results and Discussion

Canister Sample Results

Analytical results from the canister samples and calculated T values are shown in tables 1 and 2, respectively. Results of replicate analyses of the flight sample are reported in table 3, and recoveries of surrogate standards are reported in table 4. Except for an unidentified C15 alkane, the relative percent differences were less than 10 % for the replicates, and the recoveries of acetone, fluorobenzene, and chlorobenzene surrogates ranged from 81 to 97 %, which is within acceptable limits for quality assurance. The results in table 2 show that the air met NASA’s standards for air quality even without separation of carbon dioxide from other compounds that contribute to toxicological groups (T_{group} <1). Carbon dioxide, which contributed1/2 of the total T-value of 0.61, acts independently of other air pollutants, so it does not contribute to any of the traditional toxicological groups (e.g. irritants, carcinogens, neurotoxicants, etc).

Carbon Dioxide Measurements

The carbon dioxide concentrations in the middeck during the mission are shown in the figure. The carbon dioxide concentrations, as measured with the electrochemical sensors, averaged about 1.5 mmHg during the flight and showed a range from 0.6 to 2.8 mmHg. The average daily concentrations were well within the time-weighted-average SMAC of 5.3 mmHg for missions lasting several days. The circle in the figure represents measurement of carbon dioxide made by the Toxicology Laboratory on the canister sample taken during the mission. The GSC-sample concentration of 4200 mg/m3 (1.8 mmHg) was close to the electrochemical-sensor concentration (1.8 mmHg) at the time of measurement.

Conclusion

Based on assessments of an air sample from the middeck taken late in the mission, I conclude that during the STS-98 flight of *Atlantis*, the air was toxicologically safe to breathe.

____
John T. James, Ph.D.

Enclosures
1: Analytical Results of STS-98 Air Samples
2: T Values of STS-98 Air Samples